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**U. S. DEPARTMENT OF
AGRICULTURE**
FARMERS' BULLETIN No. 1072

**PRICKLY
PEAR
AS STOCK FEED**



PRICKLY PEARS may be fed to livestock in a green, succulent condition right from the field, as needed. They require no curing, housing, or storage. In this they offer an advantage over most crops.

They can be grown at a minimum of expense, only the cost of planting and keeping down weeds being involved, although the yield, like that of most crops, is in direct proportion to the care and labor bestowed.

Prickly pear will thrive where the rainfall is too irregular for most standard farm crops.

Its yields are large and cumulative, increasing from year to year, so that a heavy tonnage may be had from small areas for use at critical periods.

Prickly pear is green and succulent and admirably adapted to produce "good condition" in cattle when used with dry feeds.

Cattle in brushy pastures are known to have subsisted upon it even without water for long periods.

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PRICKLY PEAR AS STOCK FEED

By DAVID GRIFFITHS

Senior Horticulturist, Office of Horticulture, Bureau of Plant Industry

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IMPORTANCE OF PRICKLY PEAR

LIESTOCK VALUES are large, and droughty seasons are certain to occur in our southwestern "cow country," from the vicinity of the ninety-ninth meridian westward, and the resulting disaster has frequently wiped out savings and even fortunes. In such emergencies a store of reserve feed is needed which will carry stock through the period of shortage until rains come again and the normal supply of forage is restored. In southern Texas, and similar regions where prickly pear is native and rampant, fortunately the reserve is always ready. All that is necessary is to "limber up" the prickly-pear torch, destroy the spiny armature of the plant which has protected it from destruction by livestock even in seasons of plenty, and the herd is saved from the effects of a moderate drought. If the lean season is more pronounced, a pound or two of concentrates a day will be necessary in addition, so that the cattle may be kept in good condition until the season of plenty again arrives.

The prickly pear has been a decided asset to southern Texas, which is especially mentioned because it is the leading prickly-pear region of the United States. Probably 50 per cent more cattle were marketed over a term of years than could be produced were it not for this reserve supply of feed, which up to the present time has been rather overabundant. This wild crop has enabled the rancher to keep his herd intact through droughty periods, ranging from three months to three years.

This forage, though utilized in the past as an emergency feed, is capable of being made a farm crop of no mean value for more or less continuous use. It can be cultivated at a minimum of expense,

fed continuously with good effect, and with profit made a main roughage in the dairy ration.

The spines of prickly pear are indeed objectionable, but these have enabled it to persist in grazed areas. They also permit the plant to be grown as a farm crop without fence protection. On the other hand, forms of prickly pear are available in which the spines are mostly eliminated. These forms, while requiring protection from stock until needed, are just as serviceable a reserve forage as the spiny natives, and when they can be grown are much more easily handled and more acceptable generally. The planting of these spineless forms should be intelligently done, as only one species, the Ellis cactus (*Opuntia ellisiana*), is known to be hardy throughout the native prickly-pear region of Texas. This can be utilized as a reserve forage in the way recommended for the native sorts, but it will require the protection of fences.

The three-year period of drought in the Southwest in 1916-1918 emphasized the necessity for the native-pasture stockman to make provision for lean years. In the prickly-pear region such an insurance of the forage supply will entail only the cost of selecting native stocks of prickly pear, distributing them in the field, and giving them ordinary horse cultivation. In pastures where the plants already grow the husbanding of this resource is all that is required to provide against an ordinary drought, although cultivation will improve the quality of the feed and make it more valuable in time of need.

It is probable that, although all prickly-pear varieties are useful continuously in the roughage ration, their greatest value is as an emergency feed to tide over a drought and to furnish succulence for dairy cows during the short cold winter and dry summer. A few stockmen, however, already are learning in various ways to place more and more dependence upon this crop and are adopting measures to increase its production. A sufficient acreage of prickly pear to provide a partial ration for the herd during a drought is a cheap insurance.

FORMS OF PRICKLY PEAR

The plants considered in this bulletin are those members of the botanical genus *Opuntia*, whether spineless or spiny, which are suitable for use as food for stock. The terms "spineless" and "thornless" throughout this bulletin refer to those forms which are so devoid of the spiny armature as to enable cattle to eat them without artificial preparation to rid them of their spines.

The words "thornless" and "spineless" are only relative terms. No species of prickly pear is entirely without an annoying needle-like protection. The different species of the group or genus *Opuntia* to which the prickly pear belongs have two forms of spines, designated in descriptive works as "spines" and "spicules." In popular parlance "spines" and "thorns" are used interchangeably. The plants discussed here as "spineless" are nearly free from spines. They bear spicules, however, which are simply small, fragile, and easily detached spines, in varying number, but not enough to prohibit their being eaten by cattle without previous preparation. Again, in the discussions of the spineless forms, no

account is taken of forms or species¹ which are so low, small, and slow of growth as to be of little or no economic value. Some of these even withstand a great deal of cold, but they are of such slow growth and often so badly spiculed as to be of little or no value in their present condition as feed for stock. They, however, are of suggestive value to the plant breeder.

It will be neither profitable nor possible to enter into a discussion of the various spiny species which are or may be used as stock feed. There are probably no less than 200 distinct species that may be so used. So far as the practical feeder is concerned, the tonnage production of the plants he is intending to grow is the only point that needs serious consideration.

DISTRIBUTION OF PRICKLY PEARS

SPINELESS FORMS

Spineless forms of prickly pear are scattered over most of the warmer regions of the globe. To regions that have truly moist tropical climates, such species as the cochineal cactus² appear to be the best adapted. To the warm temperate regions and to the regions of periodical rainfall various species of the other genus of prickly pear (*Opuntia*) are better suited.

Spineless forms are most abundant in the Mediterranean regions of the three continents. (Fig. 1.) They are common, but never extensively cultivated, in Mexico. Frequently they are seen in the tropical and subtropical islands, while similar forms are found in South Africa, Australia, and South America. In the United States an occasional planting is found along the Florida coast. In California the spineless forms are more or less common in parks, where they were introduced many years ago. They have been distributed recently by the United States Department of Agriculture on the immediate coast of the Gulf of Mexico, in southwestern Arizona, and in southern and western California, where many small plantings from this and other sources have been established.

Prickly pears may be grown in California up to the northern tier of counties, but they do not grow well immediately on the coast. In the interior valleys the limit of their endurance appears to be reached in Butte County. At Chico they are injured by low temperatures about every third or fourth year, and occasionally they look as though they were nearly killed. If the plants are let alone, however, they recover with practically no loss. In the past they have suffered to a somewhat greater degree in portions of the San Joaquin Valley. This applies to the large rapid-growing Indian-fig group. The cochineal pear is much less hardy and can not survive the winter at Chico without protection.

In southern Texas the area where spineless prickly pears may be grown is very limited, except for the three hardy forms discussed on page 8. The plants probably will not thrive permanently north of the Texas-Mexican Railway. During the winter of 1910-11 they were cut to the ground by cold at Falfurrias, and some were injured

¹ *Opuntia vulgaris*, *O. macrorhiza*, *O. allairei*, etc.

² *Nopalea cochinchinifera*.

slightly as far south as the northern part of Cameron County. Even on the immediate coast their success is questionable.

Along the Gulf coast of the Southern States prickly pears evidently are not a paying crop. At least in certain portions of Florida they will not succeed, even though the temperatures are favorable, but they may do well in restricted sections in the southern portion of the State close to the coast.

Under irrigation in Arizona some of the hardier forms may be grown upon the valley and desert mesa lands from the Colorado River eastward as far as Tucson.

The culture of spineless prickly pears in the United States is limited, therefore, to the coast and interior valleys of California,

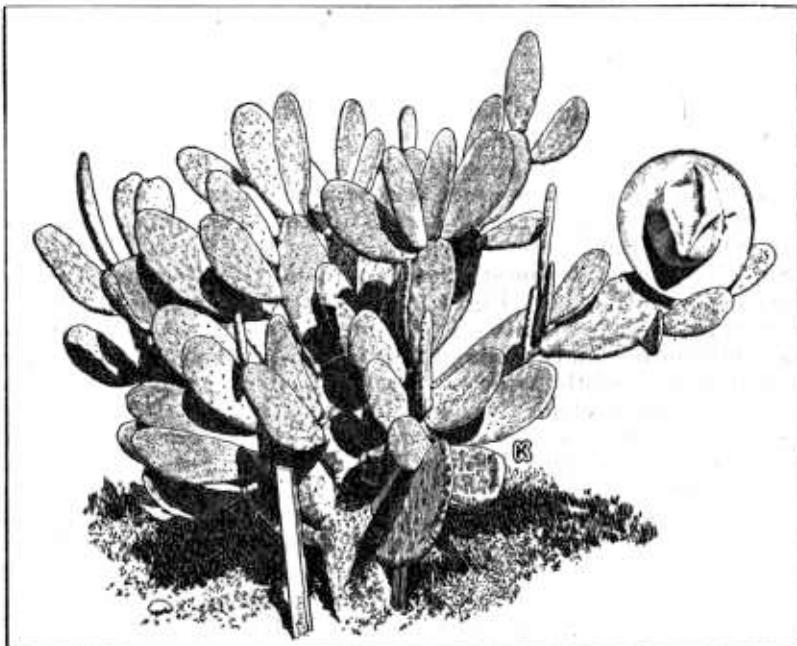


FIG. 1.—One of the best spineless species of prickly pear, a rapid grower bearing edible fruit. From the Mediterranean region of Europe.

the extreme southern portion of the Rio Grande Valley in Texas, the warmer portions of southern Arizona, and possibly portions of southern Florida. In the elevated regions of California and Arizona where there is sufficient moisture for them to grow they are soon limited by the increasingly low temperatures. The plants will not endure the winter temperatures of any locality in New Mexico.

SPINY FORMS

The regions to which the culture of the spiny forms of prickly pear is applicable are much more extensive, but are practically confined to the four States bordering Mexico. The prickly-pear region par excellence is in Texas, from the Edwards Plateau southward, a large portion of which has in recent years been cleared for cultiva-

tion. In Arizona and New Mexico the areas of native prickly pear are much more circumscribed, but a large number of useful forms are found, and they grow thickly in limited areas. To a very small extent a cane cactus is fed in Colorado and, to a much greater degree, closely related species, such as the cholla³ and tasajilla,⁴ are utilized in Arizona and New Mexico.

The greatest prickly-pear region in the world extends over the plateau and the Gulf coastal plain of Mexico. These plants are common and often abundant from there southward to Chile, and they are plentiful in the West Indies. In many other sections of the world prickly pears introduced from America have found congenial conditions and have become even more conspicuous than in this country. To Australia, South Africa, and India especially they are particularly well adapted and are considered not only a nuisance but a pernicious weed, requiring the energies of the Government to control them.

No prickly pears have been found native outside of America.

COMPOSITION AND VALUE OF THE FORAGE

At various times attempts have been made to prepare commercial foodstuffs and silage from the prickly pear. It is like silage in that it can be fed in the green succulent stage at any time of the year, but it is not well adapted to drying. It is not easy to evaporate the water content; in fact, the plant contains such a large quantity of moisture that to transform it into a dry feed is fraught with extreme difficulty. Besides, even when the difficulty of drying has been overcome, a still more potent objection is found in the fact that the dried product is not so palatable to stock, probably on account of the large quantity of mineral matter present, as is shown by the heavy percentage of ash residue when the plant is burned.

Prickly pear can be most advantageously and economically fed in the green fresh state. In this condition the plant is to be compared with root crops and immature green-corn fodder, and it should be fed in much the same manner.

Being bulky and containing much water, it can never be transported far with profit, but should be grown close to the feeding place, so that either the cattle can be turned on it to graze or the haul to the feed lot will be short. Its high water content and its high average salt content make it a laxative feed when consumed in large quantity.

In this country feeding tests with the spineless prickly pears have not been of sufficient duration or of such varied character as to warrant definite conclusions, although extensive investigations of the spiny native prickly pears of southern Texas have been made. We are warranted, however, in substituting results obtained by practical feeders and scientific investigators with the spiny prickly pears for any of the spineless ones and in making calculations accordingly.

Although practical dairymen have used the native prickly pear successfully for months at a time, with almost no other roughage, the best results are to be secured by using some dry roughage in connection with it, feeding the prickly pear in a manner comparable to silage as commonly employed—as a part of the roughage in a dairy

³ *Opuntia fulgida*.

⁴ *Opuntia spinosior*.

ration. This conclusion is based upon its chemical composition, upon the experience of some of the best-posted feeders, and upon carefully controlled tests⁵ conducted by the United States Department of Agriculture. On the other hand, some of the best herds in southern Texas have thrived on a continuous roughage ration of prickly pears and have kept in the best of condition with a rather heavy concentrate ration of cottonseed meal and rice bran. In one instance a herd of 80 to 100 cows had no other roughage for nearly two years. No injury was apparent, and the milk flow was good. Although the feed had a tendency to scour, it was the opinion of the dairymen that no injury resulted.

Many chemical analyses of prickly pears, both spineless and spiny, have been made, but often they lack essential data. Frequently it is impossible to tell exactly what forms were analyzed, but of more importance is the fact that seldom is any idea given as to what portion of the plant was used in the analysis. It is more than probable that old, woody stumps of two or more years' growth are preferable as feed to the younger, more succulent joints. Field experience indicates that cattle prefer the older joints up to the time they get too woody to be eaten.

Recent chemical investigations and scientifically conducted feeding experiments show quite conclusively that there is in general little if any difference in feeding value between the spineless and the spiny forms. In the investigations made by the Bureau of Animal Industry at Brownsville, Tex., no practical difference in the value of the two was found, nor has any been detected in the comparative value of a score of spiny species that have been fed under more or less controlled conditions. In short, the value of a species reduces itself mainly to its tonnage production.

SOIL REQUIREMENTS

One should not make the mistake of expecting prickly pear to grow anywhere and on any kind of soil. With good cultivation, a suitable supply of water, and good drainage it will thrive on almost any soil if the temperatures are suitable. Like any other crop, however, the plants make the best growth on the best soils, and this applies to the spiny, as well as to the spineless species. In any prickly-pear country the best crop will be found on the best soil.

MOISTURE REQUIREMENTS

The prevalent notion that prickly pears need no water is erroneous. The spineless species are much less resistant to drought than many of the spiny natives.

The desert mesas of Arizona, with their rainfall of 6 to 11 inches, are altogether too dry for the growth of spineless forms, even with the best of cultivation. In the upper foothills of the Santa Rita Mountains of Arizona at an altitude of about 4,000 feet, where the rainfall is 15 to 18 inches, the plants will thrive when protected from attacks of rodents, but they make only a moderate growth. With

⁵ WOODWARD, T. E., TURNER, W. F., and GRIFFITHS, DAVID, PRICKLY PEARS AS A FEED FOR DAIRY COWS. *Jour. Agr. Research* 4: 405-450, illus. 1915.

good cultivation at Chico, Calif., the winter moisture is prolonged sufficiently into the dry summer to enable spineless plants to grow vigorously from April to October without irrigation.

The spiny native forms of Arizona and New Mexico thrive at Chico even without cultivation, but those of Texas do not. These plants are surface feeders and do not draw vigorously upon the lower layers of subsoil for their moisture. In southern Texas the native species appear never to suffer from drought under even moderate cultural conditions, although no rain may fall for four or five hot months; but droughts of sufficient length occasionally do serious injury to the native species when not under cultivation.

The question is often asked whether one can afford to grow spineless prickly pears under irrigation. This question can be answered only by the grower, as it depends upon the use to be made of the crop. Prickly pears can be grown upon possibly one-third of the water required to grow alfalfa in most situations, and for this reason, if for no other, may be profitable. On the other hand, if one needs succulent feed at a time when other crops are dry and if prickly pears can be grown for that purpose, they may be made profitable.

TEMPERATURE REQUIREMENTS

So much depends upon surrounding conditions and circumstances that to predict within 5 or even 10 degrees the lowest temperature that prickly pears will endure in different places is scarcely possible. The condition of the plants at the time of a freeze and the duration of the cold weather are most important considerations. In a region like southern Texas, where good growing weather may be followed within a few hours by a temperature of 20° F., more injury will be done to the tender spineless forms than by the same temperature when the plants are dormant. Much also depends upon the conditions of the weather following the freeze. The blanket of fog that commonly obtains in the interior valleys of California during and following a cold period counteracts to a remarkable degree the effect of temporary low temperatures on the plants.

Under average conditions a temperature of 20° F., if continued for any length of time, is fatal to these spineless plants except the Ellis cactus,⁶ the Devils River spineless,⁷ and the spineless form of cacanapa.⁸ They have been injured by this temperature in extreme southern Texas. They have suffered at the same temperature in the Sacramento Valley of California, but have recovered with little loss. At that time minimum temperatures of 22°, 21°, and 20° F. were experienced on three successive nights, and freezing weather continued during the greater part of the three-day period. Under these conditions the plants were thought for a time to be practically dead to the ground, but after the coming of warm growing weather they recovered almost entirely, with a loss of only about 1 per cent of the stock. If they had been handled, however, before the warm growing weather set in there would have been a heavy loss. Roughly speaking, it can be said that 20° F. is the limit of the resistance of these plants to cold.

⁶ *Opuntia ellistana*.

⁷ *Opuntia subarmata*.

⁸ *Opuntia cacanapa*.

The same observations apply to most of the spiny highland Mexican forms that have been brought from about the Tropic of Cancer southward. The species native to northern Mexico and the United States are, of course, much more hardy, but some of the best of the natives of the San Antonio region of Texas have been known to droop considerably at a minimum temperature of 13° F. combined with below-freezing weather for three days.

Certain spineless forms, however, whose values have been demonstrated, will withstand temperatures as low as the spiny natives of southern Texas. These are forms of cakanapa, Devils River spineless, and the Ellis cactus. The last, known both as the Ellis cactus and as the San Saba cactus, is as smooth as the commercialized forms of the Indian-fig group, but does not grow so large. Its habits are very similar to those of the spiny natives of southern Texas. It thrives at Austin and San Saba and is said to be hardy as far north as Fort Worth. The origin of this species is not known. All the stock being propagated to-day is grown from cuttings obtained originally from Mexican growers at Corpus Christi, Tex., the owners being unable to give much information about it except that it came from the mountains of Mexico. It is a bush rather than a tree, like the Indian-fig group, which has been highly advertised. The Ellis cactus is now offered for sale by three or four Texas growers. One grower sells cuttings, in car lots only, at a low price. The others supply both large and small quantities at somewhat higher prices.

Another species of some promise is one of the "pest pears" of Australia,⁹ of South American origin. Forms of this species are remarkably smooth but may have to be slightly singed before being used for feed. This is one of the species that have become such pests under Australian coastal conditions. The Devils River spineless and forms of cakanapa are also remarkably smooth and hardy and should be included in a class that may prove to be valuable. They are about as smooth as the "pest pear."

IDEAL CONDITIONS FOR GROWTH

If the temperature never fell below 30° F., southern Texas would be an ideal region for the spineless prickly pear, and the cultivation of this crop would be profitable. For its best development the requirements are a good soil, an irregular, comparatively heavy rainfall, and a high minimum temperature. There are, indeed, few regions upon the mainland of the United States where the conditions are ideal for the cultivation of the spineless prickly pear except such hardy forms as the Ellis cactus. The temperature falls too low over the greater part of southern Texas, and in California the rainfall comes in the winter season when the plants are dormant. In the latter location, however, the effect of the dry summer season can be overcome in many sections by thorough cultivation, rendering it possible to grow good crops without irrigation. In the drier portions of the Southwest, from about Tucson, Ariz., to the southern Sierras, the crop must be irrigated. Throughout California the higher regions, where the temperature falls below 20° F., must

⁹ *Opuntia inermis*.

be looked upon as risky for the culture of these plants. It must be remembered that colder temperatures can be endured by most plants in many situations in California than in southern Texas. This is due to the lack of dormancy in the plants in the latter situation as well as to sudden and marked rises in temperature after hard freezes. Ideal conditions for spineless as well as spiny prickly pears are found on the highlands of Mexico, where there are two rainy seasons, one in winter and the other, more pronounced, in summer. Over much of the region a minimum temperature of 25° F. is seldom experienced.

However, as evidenced by the very rapid spread of prickly pear under conditions of close grazing, southern Texas is well adapted to the spiny natives. Conditions are especially suited to the growth of the native sorts found there and to many species that have been introduced from regions of closely similar temperatures. The larger economic species of New Mexico, Arizona, and California in general develop much more rapidly when transferred to southern Texas. From the region about the Pecos River and westward the growth of prickly pear is comparatively slow, owing to the lack of both fertility and moisture.

PROPAGATION

The stockman who grows these plants will seldom resort to anything but vegetative propagation. He will grow all of his plants from cuttings. A cutting will usually consist of a single joint, although larger portions can be used profitably if time, convenience, and economy of material are no object. Mature plants can be grown more quickly from cuttings consisting of three or four joints; indeed, large plants weighing 200 pounds or more need only to be cut off and put into the ground, and under favorable conditions they will develop root systems and soon become established provided they are not bruised in handling. If one is establishing a plantation of any magnitude, such cuttings, of course, are impracticable.

Plants can be grown readily from seed. This applies especially to the large, rapid-growing spineless species. While experience with seed propagation is rather limited in this country, it is a general principle that the spiny species come true from seed. There is more variation in seedlings of spineless varieties, which appear to have been derived from spiny species by a long process of selection. The seedlings of these spineless varieties are always more spiny than the parent stocks. Propagation from seeds, however, is slow and not to be seriously considered except in special cases where cuttings are difficult to obtain on account of long delays in transportation or when they must be transported for a great distance. In securing good mature plants from seed and from one-joint cuttings the time required will be approximately as 5 to 3 or 2.

Seeds should be planted in a seed bed with a light soil, and their treatment does not differ materially from that of other common plants grown in the same way. The beds should be well drained and kept uniformly and moderately moist. When the young plants are 2 inches high they can be profitably transferred to the nursery row or even to pots, where they may remain until they are 1 or even 2 years of age. When transplanted directly to the field the seedlings may

be planted entire or divided into two cuttings each. On account of the tendency in the seedling to be rather top-heavy, it will often be better to divide the young plant into cuttings in order to gain greater stability at maturity.

In practice single-joint cuttings 1 to 3 years old should be used. The joints planted should be well matured, 1 year or more old. Younger growths will develop very well if conditions are favorable, and in time they make as good plants as the older cuttings, but they are not as certain under field conditions. In propagating from a small supply of plants there will be no advantage in making cuttings oftener than once each season and then at the beginning of the growing period. There is almost no limit to the age of wood that will grow. Trunks that have largely lost their joint characters and become 8 to 10 years old will grow, when cut into suitable lengths and planted.

In the preparation of cuttings the stems should be divided as close to the articulation between the joints as possible, and the cut should be made below rather than above the articulation. This is not an important matter, but the closer the incision is made to the constriction between the joints the less surface there will be to heal over.

PLANTING

No plants are more easily grown than prickly pears. They are usually propagated from cuttings, which start readily. They must be in firm contact with the soil, but if the soil is moist the cuttings will usually grow, even though they are not inserted into the ground, provided, of course, the weather is not too hot, in which case scalding of the joint occurs, resulting in their destruction.

When one has but a few cuttings it is better to set them by hand. When a large planting is to be made, however, it is best to open up a furrow and distribute the cuttings at proper distances on the furrow slice. Another furrow turned in the same direction will accomplish the covering. (Fig. 2.) Subsequent cultivation will level off the ground sufficiently. The cuttings should not be completely covered, for these plants do not have the power of pushing up through the soil. The best plan is to have them covered about one-half their length. When set at an angle in this way it is thought that they make even better plants than when set upright. One of the difficulties experienced with this crop is due to the brittle nature of the stems and the lack of strength in the root system. A plant weighing 150 to 200 pounds is much less likely to topple over during a rain if the cutting is set on its side instead of upon its edge. A cutting set at an angle, as described, becomes much more stable than a cutting set upright. Besides, the cuttings are much more easily set this way. Experience indicates that deep planting is not advisable.

Much is yet to be determined regarding the proper distances to plant. The first plantings of spineless forms made by the Department of Agriculture were 3 feet apart in 6-foot rows, and this distance has been maintained at the United States Plant Introduction Garden at Chico, Calif. This is a fairly convenient and satisfactory plan for that locality. In situations where the plants grow more vigorously and consequently require more room, 8-foot rows would be more advantageous.

Contrary to general belief, the cuttings need no treatment preparatory to planting. It will do no harm, however, if they are prepared two weeks in advance, provided they are not exposed too much to the sun. Ordinarily a cutting will consist of a single joint severed as closely as possible to the constriction. This severing can be done with a sharp spade or an ordinary hoe straightened out so that the blade is in line with the handle. A whole plant can be chopped up in this way and the cuttings distributed in the furrow, as already described, and covered immediately if the weather conditions are suitable. The plants should never be handled in cold, wet weather and should not be planted in poorly drained soil. They can be handled with safety, with no drying or any other preparation of the cutting, at any season from the time they begin to grow in the spring until it gets too cold in the fall, except during the extreme heat of summer (July and August). At this season cuttings have frequently failed to root in southern Texas.



FIG. 2.—Covering spiny prickly-pear cuttings distributed in a furrow at San Antonio, Tex.

As with any other crop, it is important to secure a perfect stand and as nearly perfect plants as possible. Missing plants should be replaced by new cuttings and injured or fallen plants reset every spring at least, and oftener if necessary. When an area has been once established it is an easy matter to keep up the stand, for all that is necessary is to insert a cutting from some near-by plant.

The method of handling the cuttings will depend on the nature of the plants. The spineless forms will usually be distributed by hand, the hands being protected with a strong pair of leather gloves, but the spiny cuttings are distributed with an ordinary pitchfork. Care should be taken not to bruise and puncture the cuttings more than is absolutely unavoidable, but several fine holes will not be fatal.

It will often be advantageous to plant this crop in uncultivated pastures, especially in many portions of the Southwest. In such situations it is possible to utilize only the spiny forms, mainly on account of the danger from cold weather. The spineless forms are

excluded also because they would soon be exterminated under open-pasture conditions. The spineless species can be considered only as a cultivated crop. If the work is done while there is moisture in the ground, all that is necessary is to distribute the cuttings on the surface without covering at all. In a month they are all rooted. Crops grown in this way are slow, but they produce, at a minimum expense, a reserve supply of stock feed which is invaluable when the inevitable drought comes. A method a little more certain is to open up furrows in the pastures with a plow, distribute cuttings on the land side, and then turn the furrow slice back on the bases of the cuttings. Waste land, stony ridges, etc., can be profitably utilized in this way, especially in southern Texas.

In all operations with native spiny forms care should be used to select for planting the most vigorous and productive of the local natives of the region. Much depends on this selection.

CULTIVATION

The cultivation of the prickly pear does not differ materially from that of any other intertilled crop. In brief, the ground should be thoroughly prepared, and the subsequent cultivation should be thorough enough and frequent enough to maintain a good tilth and keep down weeds.

At Chico, Calif., where the greater part of the spineless stock of the United States Department of Agriculture has been grown, there is usually little rain from April to October. It has been the practice to clear out all weeds and put the ground in thorough condition immediately after the plants have been cut back for stock to distribute for propagation. This work usually consists of plowing with a small moldboard plow. The trampling in this plantation incident to getting out stock is very considerable and compels the use of the plow. Hoeing in the rows has also been done at this time. After that the cultivator is the important tool. The plowed middles are fined with a shovel-tooth or a spike-tooth cultivator. Putting the plantation in good condition in April saves much labor later on. All that is necessary for the remainder of the summer is an occasional cultivation with a spike-tooth or a shovel-tooth cultivator. In other regions, such as extreme southern Texas, where rains occur at irregular intervals, the same practice should govern as with other crops.

The plants are shallow rooted. The best cultivation, therefore, will not be deep. Like other plants, the prickly pears adapt themselves readily to conditions, and the roots can be made to grow deeper, but after the first preparation of the ground the cultivation should be shallow. When plowing is practiced—and undoubtedly it will be found profitable—it should be done at the initial preparation in the spring.

In southern Texas often no cultivation is possible or desirable with the spiny natives. When a maximum yield is expected, however, the maintenance of tilth is desirable, but good yields can be secured by keeping the middles worked down with the cultivator. In 6-foot rows cultivation can not usually be practiced after the second year unless the crop is harvested; then the ground can be cultivated close to the plants again.

TIME OF HARVESTING

Though both spineless and spiny prickly pears can be used continuously as roughage, it is likely that they will be more extensively used during the drier portions of the year when succulent feed is scarce. It can be said that as a general rule, in regions well adapted to grow prickly pears, the crop can be harvested at any time of the year. Certain conditions, however, modify this practice somewhat.

Cattle do not like the young joints for some time after they first form. Up to the time when they swell out and become in appearance more like mature joints they do not appear to be palatable. Considerable waste in feeding young joints occurs, and economy would suggest that it may be well not to harvest and feed until later in the season.

In regions where the winters are cold and wet it is not safe to handle the plants. Cutting the plants at this time almost invariably causes the greater part of the stems to rot, instead of healing over as during the warmer season. At Chico, Calif., no injury has resulted when harvesting has been done after the 1st of April. A great deal of rotting has resulted, however, when the harvesting has been done in November, indicating that the latter date is not safe during a cold season. The extent of the rotting will depend in largest measure on the temperature and moisture conditions immediately following such harvesting.

No experience has been had in southern Texas with spineless forms, but the probability is, judging from the behavior of native plantings of spiny forms, that a week of cold, wet weather following the harvesting will cause some rotting in the stems. Rotting, however, will never be so serious with native species as with spineless forms. Texas stockmen have never considered this factor as serious.

Attention is called to this matter here and in this definite way as a warning against the unnecessary cutting of these plants during unfavorable weather in the winter. This does not mean that they can not be used for feed in the winter, for enough of this stock can be cut at one time to last without any material deterioration for a month or more.

YIELDS

The thornless prickly pears have not been planted extensively enough nor long enough to justify a general statement regarding the yields. At Chico, where the stock of the United States Department of Agriculture is grown, no accurate records have been made. It can only be stated in a general way that the yield is satisfactory and that it is somewhere between 20 and 25 tons to the acre per annum. This, it must be remembered, is with expert cultivation and the maintenance of a perfect stand. The plantation at Chico has been carefully cultivated. All weeds have been kept down during the growing season and a good tilth maintained during the summer. Once or twice each year the whole plantation has been gone over and missing plants replaced.

Upon the yields of the spiny natives there is more accurate information. In the work of the United States Department of Agriculture at San Antonio, Tex., an average yield of nearly 24 tons to the

acre was obtained under moderately good cultural conditions, while without cultivation in ungrazed pastures the yield was only one-eighth of that quantity. At Brownsville, Tex., with more prolific varieties and more fertile soil, a yield of 32 to 50 tons per acre, depending upon the variety, was secured at the first biennial harvesting, while at the second the phenomenal average yield for all varieties was 106 tons per acre. (Fig. 3.)

With this crop, as with all others, the more nearly perfect the conditions of growth the better the yields. It is well known that the best plants grow on the best soils.

FEEDING PRICKLY PEARS

In the feeding of the spineless forms no previous preparation is necessary. Stock can be turned into small fenced-off portions of the area to graze the plants where they grow, but unless the areas eaten off at one time are small this method entails a great deal of waste.



FIG. 3.—Cultivated spiny native species of prickly pear grown at Brownsville, Tex., showing two years' growth from old stumps

It is doubtless much more economical to haul the material into a feed lot. Again, if the plants are grazed off where they stand there is danger that they will be cropped too closely. It is never well with either spineless or spiny forms to harvest lower than the joint attached to the cutting planted, and the older the plant the larger should be the stump left from which new growth is to start. (Fig. 4.)

In feeding the spiny crop two general methods have been employed. The more economical method, all things considered, has been to singe the plants with a gasoline torch and allow the livestock to graze them where they stand. (Fig. 5.) The other method is to put the unsinged plants through a chopper. The rough treatment that the material gets in passing by the strong, rapidly revolving knives results in breaking most of the spines, and the centrifugal force with which the chop is thrown out of the machine results in winnowing out many of them (fig. 6), so that cattle experience little difficulty with the feed thus prepared. Occasionally, however, an animal gets a spine into its mouth and suffers until it is pulled out. This pulling

out must be done. Cattle handle pretty rough materials normally and can eat prickly pear, spines and all, if only the tips are broken off. Camels are reported to eat the spiniest varieties of prickly pears



FIG. 4.—A harvested field of spineless prickly-pear varieties, showing stumps left for new growth

with impunity. Much of the native crop in the region from Texas to Arizona is grazed by cattle throughout the year to a limited extent with no preparation. It is a common practice for the herders in the prickly-pear region to assist the sheep and goats to get a start at a limb of the pear. They cut off the spiny edge of the joint with their



FIG. 5.—Preparing by means of a gasoline torch native species of prickly pear so the plants can be eaten by cattle

machetes, and the animals do the rest. A start is all they need. After this they can nibble away at the succulent tissues between the spines on either side.

TRANSPORTATION OF PRICKLY PEARS

Few plants are more easily handled than prickly pears. Ordinarily no special precautions are necessary in shipping cuttings, even for long distances. Cuttings or joints when distributed by mail or express are usually wrapped in newspaper and then in wrapping paper and securely tied and labeled. Occasionally cuttings become bruised when handled in this way, but the loss has been small.

On account of the bulky character of the material, the greater part of it has been distributed by freight. In such cases the cuttings in good condition are packed as tightly as possible in wooden boxes. Seldom has any paper been used. The loss is usually very small except when long delays occur in warm weather.

When cuttings are to be shipped for great distances and are likely to be in transit for two or three months it is customary to give them



FIG. 6.—Machinery used in chopping spiny native species of prickly pear so the plants can be readily eaten by cattle

special treatment. In such cases it has been found necessary to root the stock before shipping it. In warm weather the cuttings will root well in four to six weeks. They can then be lifted, cleaned, and the roots and young growth trimmed off. In this condition, when properly packed to prevent bruising, it is not at all impossible to transport them in good condition for three months or more. It has been found that a good packing for long transportation consists in wrapping each cutting separately in newspaper and then tying it in corrugated paper. This package is then wrapped and tied in wrapping paper. Cuttings in such packages, crowded tightly into wooden boxes have been carried in good condition from the United States to India.

Old cuttings are much firmer than those of one year's growth. They are harder and much less likely to be bruised, and they grow just as readily. For long-distance shipments, therefore, old joints are preferable. Probably those 2 to 4 years old are most suitable.

STABILITY OF THE SPINELESS CHARACTER

Much anxiety has been expressed by persons receiving "spineless" plants from the United States Department of Agriculture, as well as from nurserymen, as to the stability of their spineless character. The impression appears to be rather widely held that the spineless forms under certain conditions of neglect and general lack of attention will revert to the native spiny form. Nothing could be farther from the truth, for the spineless prickly pears are stable varieties which can be propagated indefinitely from cuttings. Variations may often appear, even in vegetatively propagated stocks, but the plants will not revert to more primitive forms unless grown from seed.

It is well to bear in mind that there are no prickly pears that are absolutely spineless. They all have a greater or smaller number of the small spicules and more often a few spines as well.

It should also be borne in mind that the new growth on cuttings received from the United States Department of Agriculture or from nurseries is likely to be more spiny than the cuttings when planted. This is due not to any attempt at deception, but to the fact that in packing and transporting the plants some of the spines and spicules get knocked off. Frequently the young growth has a few spines, which disappear later. Plants sold by nurserymen are only comparatively spineless. These under cultivation may and usually do produce a few spines of no particular consequence.

HOW TO OBTAIN PRICKLY PEARS

On account of the bulky and heavy nature of the material, it is impracticable to transport prickly pears for long distances in large quantities. Where the cuttings are placed 3 feet apart in 6-foot rows nearly 2 tons will be required to plant an acre. The exact quantity will vary with the nature of the cuttings and will have an immediate relation to the conditions under which they are grown. If the cuttings are large and old the planting stock will be all the more valuable, but it will make a greater weight. The expense, risk, and difficulty of transporting such quantities are considerable. For this reason it will be best for the grower to obtain a moderate quantity to start with and establish a nursery for growing his own stock.

Under fairly good conditions one cutting will yield an average of 8 to 12 plants in a season. At this rate 100 will be sufficient to stock a quarter of an acre the second year.

The United States Department of Agriculture collected and imported 25 or more spineless varieties and distributed 8 or 10 of them in large quantities. All applicants located in situations where it was possible to grow them received stock. (Fig. 7.)

About 50 nurserymen in regions where the prickly pear will flourish received a supply of these plants, but owing to a decided sag in interest in the crop a few years later only a small part of the collection has been maintained. There are, however, a number of nurserymen who still have a few varieties, and many have access to plantings in private ownership where they can get propagating material. The plantings of these nurserymen, together with those

of some of the farmers and others who were supplied with cuttings, and those of some public parks where desirable forms have been grown for years constitute the present sources of supply. Having introduced the prickly-pear stock and distributed it so widely that it can be considered well established, the United States Department of Agriculture since the spring of 1912 has made no further distributions and is not prepared to make them.

Little attention has thus far been paid to establishing plantings of spiny species outside of the regions where they grow naturally. In all plantings made the native forms of the region have been used. It is highly important in these plantings that the most careful attention be given to the varieties chosen. Those forms that pro-

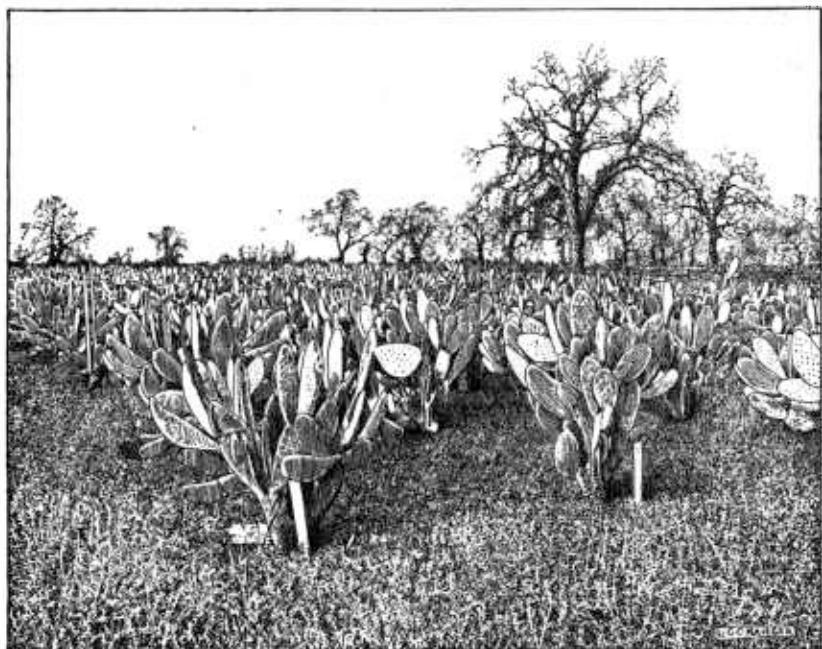


FIG. 7.—Spineless varieties of prickly pears propagated by the United States Department of Agriculture at the United States Plant Introduction Garden, Chico, Calif., for public distribution

duce the most feed in the wild state should be selected for planting. Too much emphasis can not be put on this point.

FRUIT AND FORAGE VARIETIES

There are forms, of course, that produce more desirable fruit than others, but all the forms of spineless prickly pears that are large and rapid enough in growth to be considered desirable for forage produce edible fruits of good quality. One species of the botanical genus *Nopalea*, the cochineal pear, is an exception, as its fruits are of no value. Neither is it to be considered seriously for forage in any portion of the mainland of the United States, although it is of rather rapid growth. It is promising, however, in

portions of the Hawaiian Islands. Again, the smaller spineless Ellis cactus, the Devils River spineless cactus, and others bear fruits that are not edible. All the varieties of the Indian-fig group, however, bear edible fruits, and they are forage varieties as well. Those forms which produce the greatest tonnage of plant body are

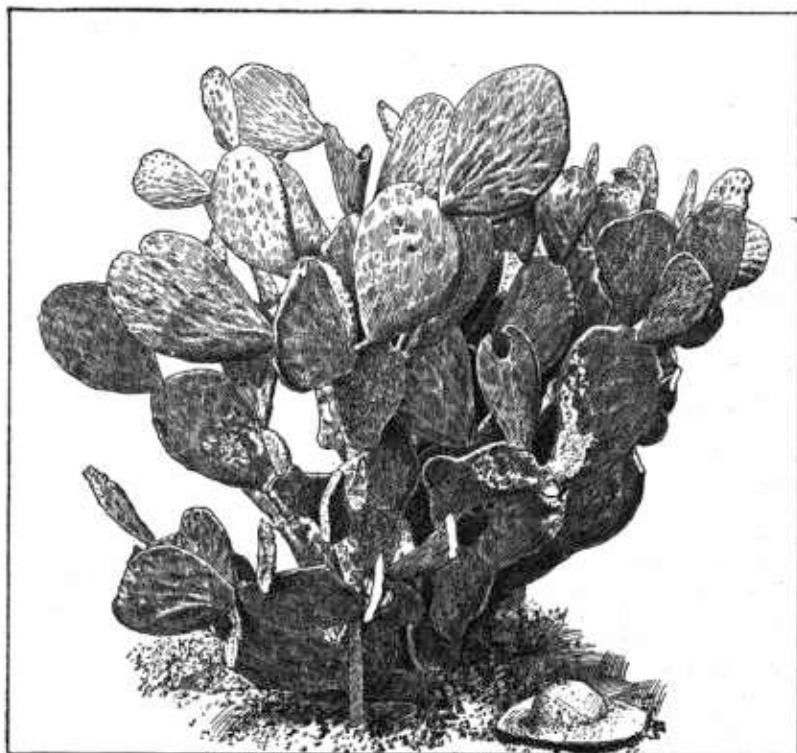


FIG. 8.—A very rapid growing species of prickly pear from Mexico having but few spines

most desirable for forage. These varieties also produce the largest quantity of the most valuable fruit.

Among the spiny natives of the United States that have been grown for forage none produces fruit of much value for human consumption, and little has yet been done toward testing the forage value of the host of spiny but good-fruited forms of the Mexican highlands (fig. 8) but experience with them indicates that they are all suitable for stock feed.

ORGANIZATION OF THE
UNITED STATES DEPARTMENT OF AGRICULTURE

November 15, 1928

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